SCIENCE NEWS

AN INTRODUCTION TO GLOBAL SCALING THEORY

by Dr Hartmut Müller © 2004

Nature continues to amaze us with an almost infinite variety of phenomena. Man has been searching for centuries to find the principle that "holds the world inside together". Today we are closer to the solution of this puzzle than ever before.

The "Sacrament" of Physical Measuring

From the time of Galileo and Newton we have known and studied properties that are common to all material phenomena: space, time and motion. These are physical properties, which explains why physics holds a fundamental position among all of the natural sciences.

Till the end of the 20th century, physics dealt with the exploration of quantitative relationships between these fundamental properties and their derivatives. In the centre of its epistemological paradigm was physical measuring, becoming something like the "sacrament" of scientific production.

At the same time, this paradigm brought about the end of the ancient student–master relationship between natural sciences and mathematics. In the academic enterprise of today, the mathematician only develops the models. It is the physicist (chemist, biologist, geologist) who decides which of the models matches the measurements and gets applied. As a result of this division of labour, mathematics became more and more "instrumentalised" and hence isolated from its intellectual source—the natural sciences.

And so it was that physics itself was demoted to a mere interpreter of models and ideas that got completely out of touch with reality—and this to an ever greater extent. Today, to calculate a modern physical model "up to last digit" and verify it by measurement is possible only for the most simplified cases.

Physical laws have degenerated to nothing more than hair-splitting; physical facts independent of a model they describe hardly exist anymore.

A Scientific Gold Mine

The scientific division of labour according to the example of large-scale industries also had its positive consequences ("Nothing is so bad that it wouldn't be useful", as an old Russian saying goes).

The physical compatibility of completely different mathematical models made it necessary to bring precision of physical measurements to unprecedented heights.

Over decades a priceless, colossal database was accumulated. It contains the spectral lines of atoms and molecules, the masses of the elementary particles and atomic nuclei, atomic radii, dimensions, distances, masses and periods of revolution of the planets, moons and asteroids, the physical characteristics of stars and galaxies, and much more.

The need for measurements of the highest precision promoted the development of mathematical statistics which, in turn, made it possible to include precise morphological and sociological data as well as data from evolutionary biology. Ranging from elementary particles to galactic clusters, this scientific database extends over at least 55 orders of magnitude.

Yet, despite its tremendous cosmological significance, this database did not become the object of an integrated (holistic) scientific investigation until 1982. The treasure lying at their feet was not seen by members of the labour-divided, mega-industrial scientific community.

The first indication of the existence of this scientific goldmine came from biology. As a result of 12 years of research, Cislenko published his *Structure of Fauna and Flora with Regard to Body Size of Organisms* (Moscow, 1980). His work documents what is probably the most important biological discovery in the 20th century. Cislenko was able to prove that segments of increased species representation are repeated on the logarithmic line of body sizes in equal intervals (approx. 0.5 units of the decadic logarithm).

The phenomenon is not explicable from a biological point of view. Why should mature individuals of amphibians, reptiles, fish, birds and mammals of different species find it similarly advantageous to have a body size in the range of 8–12 centimetres, 33–55 centimetres or 1.5–2.4 metres?

Cislenko assumed that competition in the plant and animal kingdoms occurs not only for food, water and other resources, but also for the best body sizes. Each species tries to occupy the advantageous intervals on the logarithmic scale, where mutual pressure of competition also gives rise to "crash zones". However, Cislenko was not able to explain why both the crash zones and the overpopulated intervals on the logarithmic line are always of the same length and occur at equal

Some Natural Physical Standard Measures

Name	Symbol	Formula	Value
rest mass of the proton	m_p	measurement	$1{,}67262 \cdot 10^{27}$ kg 938,272 MeV/c^2
speed of light	c	measurement	299792458 m/s
Compton wavelength of the proton	λ_p	$\lambda_p = h / (2\pi \cdot c \cdot m_p)$ (h=Planck's Constant)	$2{,}10309 \cdot 10^{-16}$ m
natural frequency of the proton	f_p	$f_p = c / \lambda_p$	$1{,}4254869 \cdot 10^{24}$ Hz
black temperature of the proton	T_p	$T_p = m_p / k$ (k=Bolzmann's Constant)	$1{,}0888 \cdot 10^{13}$ K
complete angle	2π	circumference/radius	6,2831853
unit of quantity	1	1	1

Table 1

distance from each other; nor could he figure out why only certain sizes would be advantageous for the survival of a species and what these advantages actually are.

Cislenko's work caused the German scientist Dr Hartmut Müller to search for other scale-invariant distributions in physics, as the phenomenon of scaling was well known in high-energy physics. In 1982, he was able to prove that there exist statistically identical frequency distributions with logarithmic, periodically recurrent maximums for the masses of atoms and atomic radii as well as the rest masses and life-spans of elementary particles.

Müller found similar frequency distributions along the logarithmic line of the sizes, orbits, masses and revolution periods of the planets, moons and asteroids. Being a mathematician and physicist, he did not fail to recognise the cause of this phenomenon in the existence of a standing pressure wave in the logarithmic space of the scales/measures.

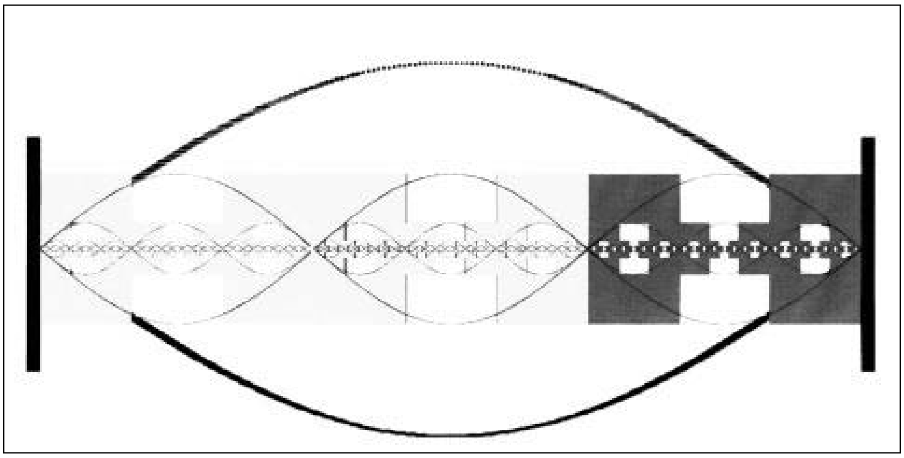
The Logarithmic World of Scales

What actually is scale? Scale is what physics can measure. The result of a physical measurement is always a number with a measuring unit, a physical quantity.

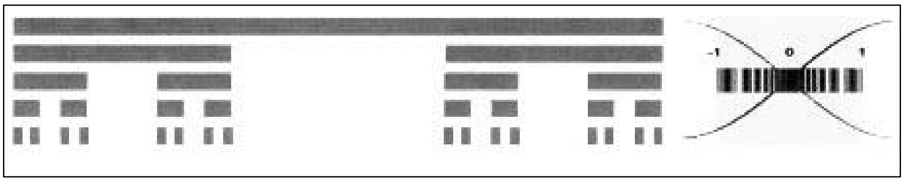
Say we have measured 12 cm, 33 cm and 90 cm. Choosing as the standard measure (etalon) 1 cm, we will get the number sequence 12…33…90 (without measurement unit or, as the physicist would say, with unit 1). The distances between these numbers on the number line are 33 – 12 = 21 and 90 – 33 = 57. If we were to choose another measuring unit such as the ell, with 49.5 cm, the number sequence will be 0.24…0.67…1.82. The distance between the numbers has changed. It is now 0.67 – 0.24 = 0.42, and 1.82 – 0.67 = 1.16. On the logarithmic line, the distance will not change; no matter what measuring unit we choose, it remains constant. In our example, this distance amounts to one unit of the natural logarithm (ln) (with radix e = 2.71828…): ln 33 – ln 12 = ln 90 – ln 33 = ln 0.67 – ln 0.24 = ln 1.82 – ln 0.67 = 1.

Physical values of measurement therefore own the remarkable feature of logarithmic invariance (scaling). So, in reality, any scale is a logarithm.

It is interesting that natural systems are not distributed evenly along the logarithmic line of the scales. There are "attractive" sections which are occupied by a great number of completely different natural systems; and there are "repulsive" sections that most natural systems will avoid. Growing crystals, organisms or populations that reach the limits of such sections on the logarithmic line either will grow no more or will begin to disintegrate, or else will accelerate growth so as to overcome these sections as quickly as possible.



The distribution of matter in the logarithmic space of scales (above) in first approximation has the fractal dimension of Cantor dust (below left), but is deformed hyperbolically in the proximity of a node point (below right)



The continued fractional structure of the distribution of matter in logarithmic space ensures that the concentration of matter in the proximity of the node point increases hyperbolically.

The Institute for Space Energy Research in memory of Leonard Euler (Institut für Raum-Energie-Forschung, IREF) was also able to prove the same phenomenon in demographics (stochastic of worldwide urban populations), in economics (stochastic of national product, imports and exports worldwide) and in business economics (stochastic of sales volume of large industrial and middle-range enterprises, stochastic of worldwide stock exchange values).

The borders of "attractive" and "repulsive" segments on the logarithmic line of scales are easy to find because they recur regularly with a distance of *three* natural logarithmic units. This distance also defines the wavelength of the standing pressure wave: it is *six* units of the natural logarithm.

By its anti-nodes, the global standing pressure wave replaces matter on the logarithmic line of scales and concentrates matter in the node points. Thus in the transit from wave peak (anti-node) to wave node, there occurs a tendency of fusion; while at the transition from node point to anti-node, disintegration tendencies arise. This process causes a logarithmic periodical change of structure. Packed and unpacked systems alternately dominate on the logarithmic line of measures at distances of 3k, i.e., 3, 9, 27, 81 and 243 units of the natural logarithm.

Sound Waves in Logarithmic Space as Cause of Gravitation

The existence of a standing density wave in logarithmic space explains, for the first time in the history of physics, the origin of gravitation. The global flow of matter in the direction of the node points of the standing density wave is the reason for the physical phenomenon of gravitational attraction. Thus particles, atoms, molecules, celestial bodies, etcetera—the scales/measures of which stabilise in the node points of the standing pressure wave—become gravitational attractors.

In physical reality, therefore, the standing density wave in the logarithmic space of scales also manifests as a global standing gravitational wave. In consequence, the exact identity of value for inert and gravitational masses of physical bodies (as it is claimed by physics today), independent of the body's density or material, can occur only in the exact node points of the global standing density wave.

So far, systematic measurements to verify this postulate of Global Scaling Theory have not been carried out. However, the Institute of Solid State Physics at Friedrich Schiller University is preparing freefall experiments (pseudo Galileo tests) at the Bremen gravity tower in order to determine the possibility of material-related violation of the equivalence principle, with a hitherto unmatched precision of < 10^{13}.

And the Satellite Test of Equivalence Principle (STEP), planned for 2004, aspires to an observational limit of c. 10^{-18}. At a height of 550 kilometres, comparisons will be made of acceleration velocities of four different pairs of test masses moving on an almost circular solar-synchronous orbit (see website http://einstein.stanford.edu/STEP).

The "Sound Barrier" of the Universe

Standing waves can only form if the medium in which they propagate is bounded. Consequently, the existence of a standing density or pressure wave in the universe means that the universe is limited by scale. At the universe's lower horizon of scale, density of matter reaches a maximum; at its upper horizon, it reaches a minimum. The two horizons constitute the universe's "sound barrier". At precisely these phase transitions, pressure waves are reflected; they will overlap and form standing waves. A standing wave can only exist for any length of time if the medium is permanently provided with energy from outside. This means that our universe is in a constant energy exchange with other universes.

Standing waves are very common in nature because every medium is limited or bounded, be it the water of the oceans, the air of the Earth's atmosphere or the radiation field of the Sun's atmosphere. Standing waves excite the medium into natural oscillations and, due to the fact that the amplitude of a standing wave is no longer time dependent but only space dependent, these eigenvibrations will move in sync across the whole medium.

A wave occurs whenever an oscillating particle in a medium excites adjacent particles into vibrations so that the process propagates. Due to the viscosity or elasticity of the medium and the inertia of the particles, their oscillation phases differ and the physical effect of a phase shift in space—termed a "propagating wave"—will arise. The rate of this phase shift (phase velocity) is always finite and dependent on the medium.

In contrast, phase velocity of a standing wave between two adjacent node points is zero because all particles oscillate in phase. This gives rise to the impression that the wave "stands". In each node point, the phase actually bounces 180 degrees—so phase velocity is theoretically infinitely high. It is precisely this property that makes standing waves so attractive for communication.

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Standing Waves as Carrier Waves for Information Transmission

Standing waves do not transmit energy; they merely pump energy back and forth within half a wavelength. Half a wavelength is completely sufficient—even for interplanetary communication—if we are dealing with standing waves in logarithmic space.

The wavelengths of standing density waves in logarithmic space are 2 x 3k, i.e., 6, 18, 54, 162 and 486 units of the natural logarithm. Half a wavelength, therefore, corresponds to 3, 9, 27, 81 and 243 units. These are relative scales of 1.3 and 3.9 and 11.7 and 35.2 and 105.5 orders of magnitude.

Exactly in these intervals, node points occur. Hence, node points mark scales relating as 1:20, 1:8103, 1:5.32 x 10^{11}, 1:1.5 x 10^{35} and 1:3.4 x 10^{105}. Within the scope of these scales, communication between two adjacent node points is possible.

The ability to modulate a standing wave is confined to its node points, because it is only in the immediate proximity of the node points that energy can be fed into or taken from a standing wave. If it is a standing wave in linear space, the node points are simply locations in which attachment of an external oscillatory process is possible.

Node points of a standing wave in logarithmic space, however, are particular scales which have different frequencies assigned to them. In order to calculate these frequencies, it is necessary to acquaint oneself with the mathematical foundations of Global Scaling Theory.

The Physics of the Number Line

The world of scales is nothing else but the logarithmic line of numbers known to mathematics at least since the time of Napier (1600). What is new, however, is the fundamental recognition that the number line has an harmonic structure which is itself the cause for the standing pressure wave.

Leonard Euler (1748) had already shown that irrational and transcendental numbers can be uniquely represented as continued fractions in which all elements (numerators and denominators) will be natural numbers. In 1928, Khintchine succeeded in providing the general proof.

In the theory of numbers, this means that all numbers can be constructed from natural numbers, the universal principle of construction being the continued fraction. All natural numbers 1, 2, 3, 4, 5, … in turn are constructed from prime numbers, these being natural numbers which cannot be further divided without remainder, such as 1, 2, 3, 5, 7, 11, 13, 19, 23, 29, 31, … (traditionally, 1 isn't classed as a prime number, although it fulfills all criteria). The distribution of prime numbers on the number line is so irregular that no formula had been found which would perfectly describe their distribution—until the Theory of Global Scaling was able to solve this mystery.

The distribution of numbers is indeed very irregular, but only on the linear number line. On the logarithmic number line, large gaps of prime numbers recur in regular intervals. Gauss (1795) had already noticed this. Thus, the set $pi(n)$ of prime numbers up to the number n can be approximated by the simple formula, $pi(n) = n / \ln n$.

The reason for this phenomenon is the existence of a standing density wave on the logarithmic number line, the node points of this density wave acting as number attractors. This is where prime numbers will "accumulate" and form composite numbers, i.e., non-primes, such as the seven non-primes from 401 to 409. Hence a "prime number gap" will occur in this place.

Precisely where non-primes (i.e., prime

clusters) arise on the logarithmic number line, there it is that matter concentrates on the logarithmic line of measures. This isn't magic; it is simply a consequence of the fact that scales are logarithms, i.e., "just" numbers.

So the logarithmic line of scales is nothing else but the logarithmic number line. And because the standing pressure wave is a property of the logarithmic number line, it determines the frequency of distribution of matter on all physically calibrated logarithmic lines—the line of ratios of size, that of masses, of frequencies, temperatures, velocities, etc.

Now, in order to find a node point on the logarithmic line, one only needs the number line (that everybody knows) and a natural standard measure with which to multiply (calibrate) the number line. The wavelength of the standing density wave on the logarithmic number line is known. The distance between adjacent node points is three units of the natural logarithm. Thus it is easy to calculate all nodal values Xn by the simple formula $Xn = Y \times \exp(n)$ (Y being a natural standard measure, $n = 0, + –3, + –6, + –9, \ldots$).

Frequency values of node points are, for example, 5 Hz (n=–54), 101 Hz (n=–51), 2032 Hz (n=–48), 40.8 kHz (n=–45), 820 kHz (n=–42), 16.5 MHz (n=–39), 330.6 MHz (n=–36), etc. The frequency ranges around 5 Hz, 100 Hz, 2 kHz, etc. are predestined for energy transmission in finite media.

This is also where the carrier frequencies for information transmission in logarithmic space are located. Frequencies that occur near a node point are not just very common in nature but are also used in technological applications.

Natural Standard Measures: The Key to Global Scaling

Exact knowledge of the harmonic structure of logarithmic space is the gateway to global scaling. In order to open the gate, one needs the key: natural standard measures (see table 1 on opening page).

Natural standard measures are themselves values of node points. In the node point of a standing wave, vibrations do not occur; there is stillness. This is why natural standard measures have a high degree of stability. The rest mass of the proton remains stable over a minimum of 10^{30} years. For the same reason also, the speed of light in a vacuum constitutes a rather obstinate value. The existence of stable natural standard measures is the physical basis of a natural metrology on which Global Scaling Theory rests.

Exact knowledge of the harmonic structure of logarithmic space is the gateway to global scaling.

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Continued Fractions as a "World Formula"

In 1950, Gantmacher and Krein proved that the spatial distribution of free-moving particles in linear oscillating chain systems can be described by a continued fraction (see below). Terskich (1955) was able to prove the same for non-linear oscillating chain systems. In 1982, Müller showed that the distribution of matter in logarithmic space also has a continued fraction structure. This structure provides that the concentration of matter increases hyperbolically in the proximity of node points.

In first approximation, the distribution of matter in the logarithmic space of scales has the fractal dimension of Cantor dust, but is being deformed hyperbolically in the proximity of a node point (see illustration).

The mathematical aspect is to be found in the realisation that not only is it possible to represent every number as a continued fraction, but the distribution of numbers on the logarithmic number line altogether can be represented as such.

This mathematical aspect has immediate physical consequences: wherever one works with numbers—be it in the natural sciences, sociology or economy—one will encounter the phenomenon that there are certain attractor values that all systems, totally independent of their character, prefer, and that the distribution of these attractor values along the logarithmic number line follows a (fractal) continued fraction rule.

This continued fraction rule "contains" physics, chemistry, biology and sociology insofar as these disciplines work with scales (real numbers), i.e., insofar as measurements are made. Many results of complicated large-scale measurings therefore can be relatively easily pre-calculated within the frame of Global Scaling Theory; for example, the temperature of the cosmic microwave background radiation, whose value cannot be larger than $T_p \times \exp(–29) = 2.7696$ K; the rest mass of the neutron $m_n = m_p \times \exp(1/726) = 939.5652$ MeV, as well as the rest masses of other elementary particles.

$$\sqrt{2} = 1 + \cfrac{1}{2 + \cfrac{1}{2 + \cfrac{1}{2 + \cdots}}} = 1{,}414213562373 \qquad \frac{\sqrt{5}+1}{2} = 1 + \cfrac{1}{1 + \cfrac{1}{1 + \cfrac{1}{1 + \cdots}}} = 1{,}61803398875$$

$$e = 2 + \cfrac{1}{1 + \cfrac{1}{2 + \cfrac{1}{1 + \cfrac{1}{1 + \cfrac{1}{4 + \cfrac{1}{1 + \cfrac{1}{1 + \cfrac{1}{6 + \cdots}}}}}}}} = 2{,}7182818\ldots$$

$$ln(X/Y) = n_0 + \cfrac{e}{n_1 + \cfrac{e}{n_2 + \cdots + \cfrac{e}{n_k}}}$$

All numbers are built from natural numbers. Their universal construction principle is called continued fraction.
Leonard Euler (1748) had already developed continued fractions for irrational numbers.
The Global Scaling continued fraction describes both the distribution of prime numbers on the logarithmic number line as well as the distribution of matter in the logarithmic space of scales.

Creation's Melody

In the context of Global Scaling Theory, the hypothesis of the Big Bang appears in a new light. A propagating shock wave (pressure wave) in linear space (the echo of the hypothetical primeval explosion) is not the cause of cosmic microwave background radiation, but a *standing pressure wave in logarithmic space* is. It is also responsible for the fractal and logarithmic scale-invariant distribution of matter in the entire universe. It created the universe as we know it, and recreates it continually. It is the cause of all physical interactions and forces—gravitation, electromagnetism, nuclear

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fusion and nuclear decay. It is the cause of the topological three-dimensionality of linear space, of left-right asymmetry as well as of anisotropy of time. All of these phenomena are physical effects which arise at the transition from logarithmic into linear space.

Neighbours in Logarithmic Space

The standing wave in logarithmic space now allows us to communicate across astronomical distances, practically without time delay. How is this possible? Systems in linear space that lie very remotely from each other can be very close to each other within the logarithmic space of scales. Our Sun and Alpha Centauri are four light-years away from each other in linear space, while in the logarithmic space of scales they are immediate neighbours. Once this is understood, it's not too difficult to create the physical conditions that will make communication in logarithmic space possible.

Two electrons on the same quantum level that may be thousands of kilometres apart are found in practically one and the same point within the logarithmic space of scales. The fact explains not just a whole range of quantum mechanical phenomena, but constitutes the basis for a totally new telecommunications technology which was publicly demonstrated for the first time on 27 October 2001 in Bad Tölz, Germany.

G-Com® technology is still in its infancy (a first language modulation succeeded in July 2001), but in two important aspects it is already far superior to any other conventional means of information transmission. Firstly, a modulated standing gravitational wave can be demodulated in any location on Earth, on the planet Mars, or even outside the solar system at the very same moment in time, thus making distances and transmission times meaningless. Secondly, no waves are generated or transmitted, which is why G-Com technology does not require aerials, satellites, amplifiers or converters.

This launches a new era of telecommunications—free from electric smog. ∞

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Editor's Note:

If readers notice discrepancies in the figures in The Logarithmic World of Scales section, these can be accounted by allowing for recurring numbers.

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